W.E.P.P. HILLSLOPE EROSION MODEL PREDICTIONS FOR NATURAL RUNOFF PLOTS

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INTRODUCTION

The USDA-Water Erosion Prediction Project (WEPP) was initiated in 1985 to develop new generation water erosion prediction technology for use in soil and water conservation planning and assessment (Foster and Lane, 1987). The WEPP computer models are based on fundamentals of hydrology, plant science, hydraulics, soil physics, and erosion mechanics. Processes considered in the model include climate, snowmelt, irrigation, soil evaporation, plant transpiration, percolation, infiltration, surface runoff, rill hydraulics, plant growth, residue decomposition, freeze-thaw, and sediment generation, transport and deposition on interrill and rill areas. The model accommodates spatial and temporal variability in topography, surface roughness, soil properties, crops, and land use conditions on hillslopes (Lane and Nearing, 1989).

The WEPP technology consists of three computer models: a hillslope profile version; a watershed version, and a grid version. The profile version computes soil detachment and deposition on a hillslope profile and provides the basis for the other two versions. The profile version applies to hillslopes similar to those for the Universal Soil Loss Equation (USLE), except that the WEPP model computes both detachment and deposition on the hillslope, as well as the total soil delivery from the end of the slope. The watershed and grid versions can estimate net soil loss or gain over a small watershed or field sized area at all points including channels.

The WEPP hillslope profile version erosion model is intended to be executed primarily as a continuous simulation model, although it can be run on a single-storm basis. By continuous simulation it is meant that the model "mimics" the processes which are important to erosion prediction as a function of time, and as affected management decisions and climatic environment. Surface residue, for example, plays an important role in terms of predicting the amount of soil lost during a given rainfall event. The WEPP erosion model uses a plant growth and residue decay model to estimate the amount of crop residue present on the soil surface for each day through the year. A certain amount of residue is generated by leaf drop during scenesence and by harvesting, and the model will adjust surface cover as a function of those processes. A pass of a given tillage implement will bury a certain percentage of a give type of residue. The model predicts this also. The user does not specify the amount of residue cover as a function of time.

The time step for most calculations in the model are daily. Soil parameters, residue amounts, crop growth, soil water content, surface roughness, and essentially all other adjustments to model parameters are made on the daily time step. Runoff and erosion are calculated on a daily basis and reported as output for each rainfall event which caused runoff.

The objective of this study is to assess the validity of the WEPP hillslope profile erosion model by comparing runoff and erosion predictions from the model to measured data from natural runoff plots and to predictions from the USLE. This paper is a status report for the project. Over 220 plots from 22 sites are being used. The data contain a total of approximately 1800 plot years of data.

METHODS

Four input data files are required to execute the WEPP profile model: 1) a climate file, 2) a slope profile file, 3) a soil file, and 4) a management file. For the case of irrigation additional input files are required, but irrigation is not considered here.

Two types of weather files are being used in the validation study, historical and generated. The historical weather uses precipitation records measured onsite the time of the rainfall events. Other weather data, such as temperatures, are taken from National Weather Service (NWS) records for the period of interest if available. In a limited number of cases the CLIGEN model (Nicks and Lane, 1989) was used to generate missing data in the NWS data base. The generated weather files were produced by CLIGEN using climate parameters from the nearest NWS station to the site for which such parameters are available. CLIGEN is a stochastic weather generator which produces statistically representative weather files for a given location which are based on distribution parameters developed from historical weather data from the location. Data from 1000 NWS stations within the US have been parameterized for CLIGEN. Most of the sites used in this study had NWS weather stations very close to the runoff plots.

The slope profile is described by length-slope pairs starting at the upper end of the hillslope. The plots used in this study were of near-uniform slope gradient, and hence were represented by a single slope segment of uniform slope the length of the plot under study.

The soil profile input is represented by up to 10 soil layers. The first line of the soil file contains general information about the soil, including soil name, texture class, soil albedo, initial saturation, and rill and interrill erodibilities. The remainder of the file contains information for each soil layer, including bulk density, saturated conductivity (if available), field capacity (if available), 5 bar water content (if available), percent sand, silt and clay, organic matter content, cation exchange capacity, and percent rock fragments.

Two type of soil files are being used in the study, one containing measured erodibility and infiltration data and one containing calculated erodibilities and infiltration parameters. Erodibility and infiltration data was collected on the same soil series at a location near the natural runoff plots from 10 of the 22 sites considered. This data was collected using rainfall simulator experiments (Laflen et al., 1987). Complete pedon descriptions were made by the Soil Conservation Service's Soil Survey Laboratory on those 10 soils at a geographic location near the natural runoff plots used in the validation study. Therefore, soils files containing measured erodibility and infiltraion parameters were developed for these ten soils. Calculated soils files were made for all the soils at the 22 sites. For these files erodibility values were calculated using the basic properties of the soils as taken from the SCS soils database located at the Soil Survey Laboratory in Lincoln, Nebraska. Infiltration parameters were set to zero values in the input files, which causes the model to calculate those parameters internally as a function of basic soil properties, including texture, organic content, and cation exchange capacity. Again, as for the erodibility calculations, basic soils information for the soil series were taken from the SCS data base.

The management file for croplands includes crop growth and residue decay parameters for the crop growth model, tillage dates, tillage implements, planting dates, harvest dates, yields, information on contour farming (if any), information on weed cover, and information on the size of equipment used. Management files were constructed from records of management practices used at the experimental sites.

Four cases are being analyzed in this study. Case 1 is the historical case. The conditions for the plots are represented as exactly as possible, in that historical weather data and measured soil erodibility and infiltration data is used. Since only 10 of the sites have measured soils data, Case 1 applies to only those 10 sites. Case 1 should represent the "best case" parameterization for the model in terms of matching the conditions for the data used. Case 2 is the simulated case for which generated climate files and calculated soils parameters were used. Case 2 represents the "worst case" in terms of model parameterization. Case 2 is done for all 22 sites. Case 3 is the soil test case which uses measured precipitation data and calculated soils parameters using basic soil series information. Case 3 tests the model validity in terms of calculated soils information where precipitation data is as "good" as possible. Case 3 is applied to all 22 sites. Case 4 is the weather test case which uses measured soils information with generated weather files. Case 4 tests the weather generator under "best" conditions of soils parameterization. Case 4 can only be applied to the 10 sites where measured soils data exists.

Comparisons of total runoff and soil loss will be made between each of the 4 cases under study, the measured data, and the USLE predictions (for soil loss). Cumulative frequency distributions will also be used to compare the differences between each case.

STATUS

Management, climate, and slope files have been constructed for all of the sites. The measured soil files have also been completed, but additional information is being located for the construction of the calculated soils files.

Several preliminary runs have been made using a early releases of WEPP to test various aspects of the model (Nearing et al., 1990). Information from studies such as this will be used to identify weaknesses in the WEPP technology so that appropriate improvements may be made. Initial results from this study should be availible by June, 1990.

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TABLE 1. Description of Georgia Plots Used in The Validation Study.

Plot	Dimensions ft.	Slope		Cropping	Years
TIFTON, GA. Soil is Tifton Loamy					
1-1	26.2x83.0	3.0%	Contour	Meadow-Meadow-Corn-Peanuts	52-66
1-2	26.2x83.0	3.0%	Contour	Peanuts	52-59
			---	Fallow	60-66
1-3	26.2x83.0	3.0%	Contour	Peanuts-Corn-Oats	52-66
1-8	26.2x83.0	3.0%	Contour	Meadow	52-55
			Contour	Corn	55-66
2-6	Replication of 1-1				
2-4	Replication of 1-2				
2-5	Replication of 1-3				
2-1	Replication of 1-8				
WATKINSVILLE, GA. Soils by series are 1-Cecil sandy clay loam, 2-Cecil sandy loam, 3-Cecil clay					
1- 2	20.74x70.0	3.0%	Contour	Cotton	53-60
2-24	20.74x70.0	7.0%	Contour	Cotton	53-60
3-34	20.74x70.0	11.0%	Contour	Cotton	53-60
2- 7	20.74x70.0	7.0%	Contour	Meadow-Meadow-Corn	53-60
2- 9	20.74x70.0	7.0%	Contour	Meadow-Corn-Meadow	53-60
2-11	20.74x70.0	7.0%	Contour	Corn-Meadow-Meadow	53-60
3-27	20.74x70.0	11.0%	Contour	Corn-Meadow-Meadow	53-60
3-29	20.74x70.0	11.0%	Contour	Meadow-Meadow-Corn	53-60
3-30	20.74x70.0	11.0%	Contour	Meadow-Corn-Meadow	53-60
3-25	20.74x35.0	11.0%	Contour	Corn-Meadow-Meadow	53-60
3-28	20.74x35.0	11.0%	Contour	Meadow-Meadow-Corn	53-60
3-26	20.74x35.0	11.0%	Contour	Meadow-Corn-Meadow	53-60
2-13	20.74x70.0	7.0%	Contour	Meadow-Meadow-Corn-Cotton	53-60
2-19	20.74x70.0	7.0%	Contour	Cotton-Meadow-Meadow-Corn	53-60
2-21	20.74x70.0	7.0%	Contour	Meadow-Corn-Cotton-Meadow	53-60